



Basal ganglia circuits: what's now and next?

Jose L. Lanciego*

Neurosciences Division, Basal Ganglia Neuromorphology Laboratory, University of Navarra, Pamplona, Spain

*Correspondence: jlanciego@unav.es

The current model of the basal ganglia was introduced two decades ago and has become the basis for most of our current understanding of basal ganglia function and dysfunction. Extensive research efforts have been carried out in recent years leading to unprecedented levels of understanding of the main operational principles underlying the pathophysiology of the basal ganglia. Although somewhat obsolete, the “classical” basal ganglia model developed in the mid 1980s by the “founding fathers” (Penney and Young, 1986; Crossman, 1987; Albin et al., 1989; DeLong, 1990) still maintains a remarkable appeal. This model was shaped mainly by the preponderance of anatomical and physiological data available at the time. In the past few years, the development of a whole range of new technical breakthroughs has boosted the availability of data with paramount importance at a breath-taking speed, and thus incorporating these recent advances to further enrich the classical model has become an urgent need.

With this idea in mind, we took advantage of Frontier’s philosophy (peer-review policy, open access, web resources, and so on) to recruit a panel of leading experts in different fields of basal ganglia research to prepare focused reviews in their own areas of expertise. It gives me great pleasure to point out that they all (with only one exception) agreed immediately to participate. Besides invited reviews, eight unsolicited reviews have also been incorporated in this Special Issue after going through the standard review process. In addition to all contributors, it is also worth acknowledging the superb assistance received from all individuals reviewing the submitted manuscripts. As a part of Frontier’s policy, the individuals involved in the review process are listed on the front page of each accepted manuscript. Submitted manuscripts were published immediately after acceptance without waiting for the entire Special Issue to be completed. Accordingly, the first paper to be published, prepared by Barroso-Chinea and Bezard (2010), appeared in mid-September whereas the last paper was issued by Lanciego and Obeso (2011) in July.

Although it is practically impossible to cover the whole range of new arrivals to the field with just one Special Issue, my feeling is that with all things considered we have managed to prepare a body of literature with an adequate balance between solicited and unsolicited contributions, representing a good reference for those trying to get started with the basal ganglia, particularly PhD students.

With regards to invited contributions, bearing in mind that we are dealing with basal ganglia circuits, a number of topics have been addressed in-depth. Firstly, Reiner et al. (2010) have written a comprehensive review on corticostriatal projections. Nigrostriatal and nigroextrastriatal projection systems are addressed in the contributions made by González-Hernández et al. (2010) and Rommelfanger and Wichmann (2010), respectively. Moreover, since striatal interneurons have often been neglected in the basal

ganglia model, there are two contributions devoted to this topic: a review dealing with cholinergic interneurons (Bonsi et al., 2011) and another review focusing on all different types of GABAergic striatal interneurons (Tepper et al., 2010). It is also worth noting that we wanted to stress the role played by subcortical basal ganglia loops in modulating basal ganglia function. Two contributions deal with this topic: one by Redgrave et al. (2010) with a focus on the superior colliculus and the other highlighting the role of the pedunculopontine nucleus in basal ganglia circuitry (Martínez-González et al., 2011).

The main research area that was neglected in this Special Issue is the thalamostriatal system. Although several of the invited senior authors possess an in-depth knowledge of this system, most of them were already engaged in other topics and I did not wish to overwhelm with additional commitments. For those interested in the thalamostriatal system, I would suggest reading recent reviews prepared by Smith et al. (2009, 2011). Moreover, the presence of projections arising from the subthalamic nucleus and reaching the ventral motor thalamus directly (without going through the output nuclei) has been reported by Rico et al. (2010). However, this paper was published too close to this issue to merit preparing a focused review and therefore was not considered as potential content for this Special Issue.

Two contributions emphasize a holistic view of basal ganglia function: one addresses the somatotopic organization of basal ganglia (Nambu, 2011) and the other focuses on functional anatomy and dynamic states of basal ganglia circuits (García-Munoz et al., 2010). Finally, in an attempt to provide some clues on basal ganglia dysfunction in diseased states, we have incorporated two invited contributions. The first paper addresses striatal spine plasticity in parkinsonian conditions (Villalba and Smith, 2010), a hot topic that has recently attracted intensive research efforts by the scientific community. The second paper reviews the current knowledge on basal ganglia circuits underlying the generation and maintenance of levodopa-induced dyskinesia (Barroso-Chinea and Bezard, 2010), a clinical entity with devastating effects in the daily lives of parkinsonian patients.

Finally, unsolicited contributions have also played a crucial role in shaping the final outcome of the Special Issue, all of which were very much welcomed. Two manuscripts deal with subcortical striatal afferents from different sources (Day-Brown et al., 2010; Pan et al., 2010), whereas another extensively reviews the degree of segregation of striatal output pathways (Bertran-González et al., 2010). One manuscript represents a comparative neuroanatomical work of the tree shrew striatum (Rice et al., 2011). Last but not least, two manuscripts address different aspects, such as basal ganglia circuits underlying sleep-wake regulation (Vetriveland et al., 2010) and thalamocortical integration of cognitive and emotional processes as seen with high-field fMRI.

All the aforementioned contributions have been collated here in a single e-book. I hope that this information may be useful for novice researchers approaching this exciting research field, the basal ganglia. Once again, my most sincere congratulations to all the individuals involved in any way during the preparation of this Special Issue. In addition to authors, co-authors, and reviewers, I must acknowledge the superb support received from Frontiers Team members at all times.

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